

## OBJECTIVES IN THE DESIGN OF RURAL TELEPHONE SYSTEMS

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#### 1. GENERAL

1.1 This section is intended to provide REA borrowers, consulting engineers, and other interested parties with technical information for use in the design and construction of REA borrowers' telephone systems.

1.2 This issue replaces TE & CM Section 201, Issue No. 3, November 1959. The purpose of reissuing the section is to focus on additional objectives and new considerations to be kept in mind in the design of a rural telephone system.

1.3 The controlling objective in the design of a telephone system is to provide adequate telephone service in the area to be served at the lowest practical annual cost. This section describes the means and procedures recommended for attaining this overall objective. Most of these apply to the preparation of the Supplemental Loan Proposal discussed in REA Bulletin 320-14 or the Area Coverage Design described in REA TE & CM 205, "Presentation of an Area Coverage Design."

1.4 The objectives described in this section are derived from the statement of Congressional Policy contained in the legislation under which the Rural Electrification Administration operates, which reads as follows: ". . . it is hereby declared to be the policy of the Congress that adequate telephone service be made generally available in rural areas through the improvement and expansion of existing telephone facilities and the construction and operation of such additional facilities as are required to assure the availability of adequate telephone service to the widest practicable number of rural users of such service."

1.5 Detailed information on subjects mentioned may be found in other sections of the Telephone Engineering and Construction Manual. Refer to the index TE & CM Section 102 for guidance.

## 2. MAJOR ELEMENTS OF A TELEPHONE SYSTEM

2.1 A telephone system's physical plant is made up of the following:

2.11 Equipment on the subscribers' premises. This is known as station equipment.

2.12 Physical or electronic circuits connecting the subscribers' equipment with the central office. Most of this investment is in what is known as outside plant.

2.13 Central office switching and toll equipment: This includes local switching equipment and automatic number identification, or automatic toll ticketing equipment. If there is a toll office, there will also be toll dial equipment and a toll switchboard.

2.14 Trunks to other offices. These include extended area service (EAS) trunks to nearby exchanges and toll trunks to a toll center where connection is made with the world wide toll network. Special service trunks, foreign exchange, and private lines are also in this category.

2.15 Electronic Transmission Equipment. Prior to 1970, electronic transmission equipment was a relatively small part of a rural telephone system's investment, and it was nearly all located in the central office. Today it is growing at an accelerating rate as electronic equipment is used to reduce the cost of trunk and subscriber circuits. Included in the electronic category are subscriber and trunk carrier, electronic subscriber switching systems, voice frequency repeaters, microwave equipment, and mobile radio.

2.16 Buildings. These house central office equipment, headquarters and commercial offices, and toll operating rooms. Garages or storerooms are also included in this category.

2.17 Operating equipment includes furniture, office machines, tools, test equipment and vehicles.

2.2 Each element in a telephone system must be designed to work with all other elements so that any telephone user can be connected with any other telephone in his own exchange, in any directly connected exchange, or in any exchange connected to the world wide telephone network. The facilities provided for each element should be coordinated so that there will be a reasonable balance in quantities or space provided. Substantial shortage or surplus in any item should be avoided. Great care should be used in estimating the growth in subscribers and the services they will require.

### 3. AREA COVERAGE

3.1 The telephone system should be designed with the objective of providing all applicants in the geographical area of the telephone company with the services desired. All persons included in the project for which the loan is made, to a maximum practical extent, shall be served without payment of any contribution in aid of construction or mileage or zone charge for the lowest grade of service in each central office area.

### 4. ADEQUATE SERVICE

4.1 To provide "Adequate Service," the system should be designed to meet the expectations of the large majority of telephone users in the area served with regard to an adequate number of conversation paths (intra and inter office trunks), clearness of speech, low noise, dependable signalling, reliability of service, number of subscribers on a line, direct distance toll dialing, extended area local dialing, and other features of modern telephone service.

4.11 Close adherence is required to the recommendations in the sections of the Telephone Engineering and Construction and Telephone Operations Manuals, and the requirements of REA specifications. Using materials on REA's List of Acceptable Materials and adequately trained craftsman performing an acceptable level of preventive maintenance are also necessary to assure meeting and maintaining the objective of high quality telephone service.

4.2 Adequate service includes the availability of different classes of service to meet the requirements of individual users. The design therefore should include provision for classes of service usually offered in a modern telephone system to the extent of the demand for each class in individual exchanges. In the seventies this will likely include mobile radio, paging, pushbutton dialing, call waiting, call forwarding, abbreviated dialing, conference calling, key systems, local message recording, and data service, to name the most popular.

4.3 Provision should be made in the switching equipment for local governments to handle 911 emergency service. Provision must be made for handling Information, Assistance, and Toll calls. The latter activities, for economic reasons, are usually centralized at a toll center owned and operated by a larger telephone company.

4.4 Telephone users generally are willing to pay a toll charge on calls to distant cities, but to nearby points to which there is a high community of interest, they want "free" service, generally known as Extended Area Service or EAS. Of course, it is not free, but simply means that the cost (including the loss in toll revenue) is included in the rates for local service. In designing a telephone system, the objective is to meet the wishes of a large majority of subscribers in providing adequate EAS but to avoid extending it to points desired only by a bare majority or a minority of users.

... rural telephone systems still have 40 percent or more eight-party or four-party subscribers. The objective even on eight-party lines is to have the subscriber hear only his own ring. Where no selective interference makes this impractical, not more than two parties should hear each ring.

The three-party service is the objective for rural service. A maximum of four parties on a line should be the minimum objective for systems that must move to all one-party in the immediate future.

Another objective is meeting all requirements of the Nationwide Toll Dialing Plan. The requirement of seven-digit toll dialing, adequate direct trunks to the toll center, subscriber dialing capability (DDD), and adequate intercepting arrangements are important and their cost is reflected in the toll settlement.

To serve the "widest practical number of rural users," the cost for telephone service must be kept as low as practical and still meet the requirements of adequacy, high quality, reliability, and financial soundness. The design of the system is based on the Area Coverage Survey, which considers long range growth estimates, and should take into account not only the initial cost but also the operating expenses, including maintenance and depreciation, feasibility of expansion, flexibility, and other factors that will be reflected in the rates charged. Although subscriber circuits of 50 miles or more are possible, carrier and switching systems provide a more flexible plant than cable construction, since it is easier to move or expand when estimated growth is exceeded or is exceeded. Each item adding to the cost of the system should be considered from the point of view of what it contributes to adequate rural service and should be included in the design only if the benefits offset the annual cost.

In determining the number of central offices needed to best serve an area, the cost of eliminating a small step office is balanced against the cost of outside plant and subscriber electronic equipment, reduced EAS and toll trunks requirements, the effect on system maintenance and operation, and on local and toll revenues. One or a few large sophisticated common control switchboards can provide the new telecommunications services much more than many small offices. The rates of growth considered, since the differential in and two small central offices and the difference in outside plant may be areas.

Starting or replacing a dial central office or one or two offices should be considered, the more flexible plan

s preferable. This favors a single office and carrier equipment for the subscribers' lines considered for the second office. Carrier equipment is considered permanent plant, but it can readily be moved or expanded. Once a central office is installed, little can be done to reduce the annual charges if it is found later that one office would have been adequate.

5.3 In general, the most economical location of a local central office is at the wire center of the area served. However, a central office with considerable electronic equipment substituting for cable pairs may be at some distance from the wire center with little or no increase in the cost of outside plant. This permits selection of a site which is most favorable with regard to accessibility, nearness to power supply, cost of land, terrain conditions, and other features.

5.4 Where a central office building contains a commercial office or a toll operating room, the objectives include accessibility to the public and to employees. This does not mean, however, that the telephone office has to be in the best business section of the town. Most telephone offices of this type are located where it is still convenient to the public and employees, where parking space is available and where land is cheap enough to permit providing adequate space, both initially and for growth.

5.5 Usually the most satisfactory system design is to provide a minimum number of unattended dial offices and to concentrate the handling of Information, Assistance, and Toll traffic at the Toll Center. Where there is a question whether a very large exchange should be an unattended office or an operator office, the controlling factor is the relative operating cost, taking into account of course, the toll settlements and payments to connecting companies.